THE STRATIGRAPHY OF THE LOWER MARINE SERIES OF THE PERMIAN SYSTEM IN THE HUNTER RIVER VALLEY, NEW SOUTH WALES.

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(Two Text-figures.)

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Contents.

Introduction.

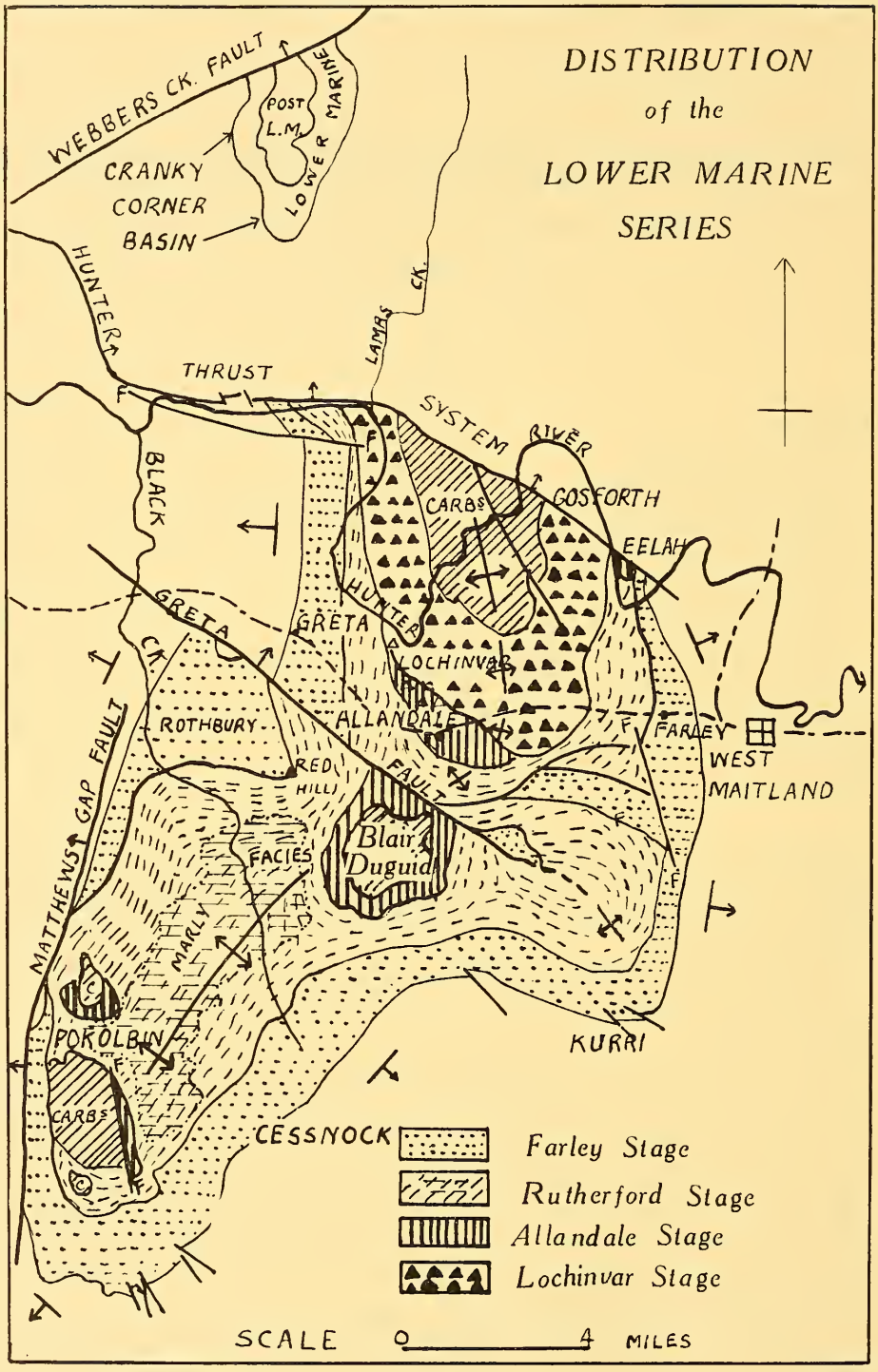
During several field seasons between 1939 and 1946 the stratigraphy of the Lower Marine Series in the Middle and Lower Hunter Valley has been examined and carefully measured. This series has not received much detailed field investigation in the past, although it has been the subject of much discussion and correlation by stratigraphers and palaeontologists.

The chief aim of the writer has been to establish, as completely as possible in the time available, the detailed succession in many areas, and to study the facies variation from place to place.

Numerous sections have been measured, and some correlation of these has been attempted. Much information concerning the structure of the Lower Marine Series has accrued from the field-study, particularly concerning the area between Bishops Bridge and Ravensfield, and also in the Pokolbin district, but the writer does not intend to discuss tectonics beyond the mention of certain structural relations between the various stages of the Lower Marine, where the consideration of these relationships assists in an understanding of the stratigraphy. The tectonic evolution of the Lochinvar Dome, and particularly the special character of the Pokolbin section of the Dome, are matters of no small importance in any structural survey of the region, and these subjects will be reserved for separate communication.

The field-work occupied about twelve weeks and during this aggregate period approximately 500 carefully selected samples were obtained. Apart from a considerable amount of work on foot, about 1500 miles of traverse were made along transport routes.

Some general idea of the geographic distribution of the various stages is obtainable from inspection of the accompanying map (Text-fig. 1).



Text-figure 1.

It must be stressed that not only was there insufficient time for the mapping of the various horizons throughout the basin, but it was found that with the exception of the Ravensfield sandstone, and the basalts, many of the strata varied in lithology along the strike so as to make difficult any correlation for survey purposes.

In running the sections specimens were taken at very short stratigraphical intervals, often from points five feet (stratigraphically) apart, and occasionally with even smaller intervals. Of course in many places where the lithology was fairly constant for some considerable thickness, the frequency of the specimens was less.

In the past the Lower Hunter region has received a great deal of attention from geologists chiefly because of the extreme scientific interest of the rocks in the area, and also because of the occurrence within the Permian System of the Greta and Newcastle Coal Measures. The writer does not propose to review in detail the course of geological investigation in the area as this has been done in other works. It will be sufficient to remind the reader that the most important work in the past was the establishment of the sequence and the elucidation of the structure of the Permian rocks of the great Lochinvar structural province and associated areas, by the late Professor Sir Edgeworth David in his survey of the Hunter River Coalfield, begun about 1884 and continued at intervals until the publication of the Hunter River Memoir (1907) and even in later years. Professor David made it clear in his writings that a detailed study of the Lower Marine Series was not undertaken by him and his associates since the chief task was the mapping and examination of the coal measures.

In 1913 A. B. Walkom made some detailed investigations of certain Lower Marine sections in connection with a study of the stratigraphy of the Maitland–Branxton district.

A considerable amount of palaeontological research extending over a long period of time has been done upon both megascopic and microscopic fossils from the area (see reference list).

In dealing with the Carboniferous–Permian problem, H. G. Raggatt and H. O. Fletcher (1937) reviewed the Permian stratigraphy in the Hunter River district and suggested the term *Allandale Stage* for about 800 feet of strata formerly grouped in the upper part of the Lochinvar Stage. The stratigraphical thicknesses given in their Lower Marine Section (1937, p. 153) must now be superseded by the data available from the writer's detailed investigation.

The writer does not think it necessary in the stratigraphical section of this paper to enumerate all the fossils recorded from the respective areas under discussion. It will be apparent from the following pages that the correlations of various horizons in the Hunter Basin can be effected by means of a few (often one or two) prominent species amongst the faunas, and thus complete lists of fossils from any two equivalent horizons are not always necessary for comparative purposes. It will thus be the practice here to refer occasionally to the most important or most abundant fossils found on leading horizons.

However, at the end of the paper lists of megascopic fossils from the various stages are given. These are taken mainly from Walkom's paper and are not intended to be absolutely complete. They are listed for the purpose of saving the time of any future worker dealing with the Lower Marine.

With regard to the micro-fauna of the series, the samples of the various horizons were collected in partially weathered or friable condition, from which some studies have already been made by Miss Irene Crespin (see list of references). Particular attention was given to collection of material from the foraminiferal limestones and other marly rocks near Pokolobin and elsewhere.

THE LOWER MARINE SERIES.

Geographic Distribution.

The Lower Marine Series outcrops over a region of about 200 square miles in the Lower Hunter district. A small area of volcanic rocks of the Lower Marine occurs near Muswellbrook. The Lower Hunter outcrops include a large area within the girdle of the outcrop of the Greta Coal Measures, extending from a little to the north of Maitland

right round the flanks of the Lochinvar Dome marking out an irregular semi-elliptical boundary which ends on the north-west in the neighbourhood of Branxton and Elderslie.

In addition to the main Lower Marine province there are the Paterson–Mindaribba Basin composed partly of Lower Marine rocks, and the country east of Paterson where the series has a much reduced development. Again, in the Cranky Corner Basin, north of the Hunter River, Lower Marine rocks outcrop in a continuous subcircular belt forming the lowest of the three Permian divisions of that locality.

Areas of Regional Development.

It is possible to divide the area of the Lower Marine upon the basis of the development of certain distinctive lithological facies of sedimentation. Thus we may recognize the following geographic subdivisions:

(i) Gosforth–Lochinvar District.
(ii) Paterson–Seaham District.
(iii) Aberglasslyn Estate and its environs.
(iv) Eelah–Comerfords District.
(v) Farley–Ravensfield–Bishops Bridge–Rutherford areas.
(vi) Allandale and Harpurs Hill.
(vii) Old Rothbury–Rothbury–Greta District.
(viii) Pokolbin–Milfield District.
(ix) Cranky Corner Basin.

The Muswellbrook District Lower Marine forms a separate entity, geographically and lithologically.

Relations between the Lower Marine Series and the Kuttung Series.

The general relationship of these two series is that of conformity, as there is no marked divergence in the strikes of the two series at any place, nor, with the exception perhaps of the section at Pokolbin, any noteworthy difference in the amount of dip. Small differences of dip, such as do occur, are those to be expected where overlap has been in progress. Near Lochinvar there appears to be no break whatever between the uppermost terrestrial Carboniferous rocks and the lowermost Permian.

The section at Pokolbin was interpreted by Professor David as showing a strong unconformity between Lower Marine and Carboniferous. The present writer, however, considers that the structural relations are the result of overlap followed by the epi-Permian folding of Lower Marine sediments which had been deposited upon an eroded Carboniferous basement during an uplift of Kuttung islands in the Lower Marine sea. This will be referred to again in a later section.

The general overlap in the Hunter Region is clearly displayed by the features shown on Professor David's map. Starting in the Luskintyre–Gosforth district and proceeding east or west along the margin of the Carboniferous province, one can trace the gradual encroachment by successively younger beds of the Lower Marine over the Kuttung floor. Near Raymond Terrace the effect is so strong that Upper Marine rocks rest directly on Kuttung tillites.

Palaeogeographical Setting.

Fortunately the Lower Marine Series in the Lower Hunter forms a fairly well-defined province, and in any investigation of the stratigraphy and lithological variation of the rocks, one can obtain an understanding of the palaeogeographical conditions within the confines of the present development.

It appears that the land in late Kuttung time did not stand very high above the sea. The invasion of the Kuttung land by the sea began in the neighbourhood of Gosforth. Gradually the Lower Marine Series began to increase in development, and, as W. R. Browne (1926) has pointed out, the region of maximum sedimentation was along the line which later formed the axis of greatest uplift.

We may note that there was probably no high ground adjacent to the region until the beginning of the *Allandale Stage* (see below), when a distinct epeirogenic episode

occurred, elevating some of the Carboniferous floor of the Lower Marine geosyncline, and producing islands that now constitute the inliers of Blair Duguid and Pokolbin.

Following this uplift erosion gradually wore down the Kuttung hills, and sinking allowed the accumulation of much sediment. Eventually the Lower Marine sea disappeared from the region as a result of the operation of two factors, (i) the silting of the deposition-area, and (ii) actual retreat.

STRATIGRAPHY OF THE LOWER MARINE SERIES.

The general succession given by Professor David in the Hunter River Memoir (1907) was as follows:

Farley Stage, with Ravensfield Sandstone at base.
Lochinvar Stage, with Lochinvar Shales at base.
Approximate total thickness, 4,800 feet.

Arising out of the writer's detailed work, the following classification is used in this paper:

Farley Stage (with Ravensfield Sandstone at base).
Rutherford Stage (with Bishops Hill tuff at base).
Allandale Stage (with Allandale Conglomerate at base).
Lochinvar Stage (with Gosforth Shales at base).

THE LOCHINVAR STAGE.

1. *The Gosforth Section.*

W. R. Browne and W. S. Dun (1924) discussed the stratigraphy of the basal portions of the Permian System as exposed at Gosforth, and at that time (following Professor David) regarded the Lochinvar Shales (with glacial erratics) as the basal unit in the System. In recent years, in connection with the completion and revision of the David Book on the Geology of Australia, Dr. Browne (verbal communication) has finally placed the Lochinvar Shales as the topmost horizon in the Carboniferous Kuttung Series. Thus the lowest horizon in the Permian is that of the shales and mudstones with *Eurydesma hobartense*, which here will be called the *Gosforth Shales*. Immediately succeeding the shales is a well-developed sandstone and sandy tuff carrying plant stems and showing pebbly phases. This rock persists along the strike for a distance of about eight miles and is about 80 feet thick. In places it carries marine fossils, *Dielasma* being the most abundant, and *Spirifer* also common. Next succeeding are some olive-green calcareous mudstones which are followed by 600 feet of basalt. This is overlain by 200 feet of shale which passes into calcareous material and eventually merges into a local bed of limestone about 10 feet thick which is exposed in a creek a little to the south-east of Gosforth Church. This bed carries quite a varied fauna, the chief type being *Fenestella internata*, *F. fossula*, *Martiniopsis subradiata*, *Spirifera* aff. *tasmaniensis*, *Deltopecten linaeformis*, *Aviculopecten englehardti*, *Aviculopecten mitchelli*, *Chaenomya* sp., *Moeonia* sp. (from list given by Browne and Dun).

The limestone is overlain by buff-coloured sandstone and tuffaceous sandstone which are about 150 feet in minimum thickness and are overlain by decomposed vesticular basalt and basic tuffs. This basic rock is exposed in a quarry just north of the main road about 1·8 miles from the junction with the Gosforth Road. Here the section is:

	Feet.
Hard fine-grained tuff	20
Sub-spheroidal basic tuff	15
Olive-green mudstone	10
Decomposed basalt	10
Buckled mudstone	15
Spheroidal basalt	100

The dip here is E. 15–25 S. at 50°.

These basaltic rocks form the second group of flows, etc., in the lower part of the Lochinvar Stage, and they can be traced from the Gosforth Road across the northern road to a hill to the south-east of Lochinvar.

The record section may be taken as typical of the lower part of the Lochinvar Stage for the region lying just east of the axis of the Lochinvar Dome. A summarized statement follows:

	Feet.
Basalt and basic tuffs with interbedded mudstone	170
Sandstone and tuffaceous sandstone	150
Limestone	10
Shale with calcareous shale at top	200
Basalt	600
Plant-bearing sandstone and tuff, with marine fossils	80
Gosforth shales with *Eurydesma hobartense*	9
Total	1,219 Feet

Further details of the second group of basalts and associated strata are available in the property near the Gosforth Road, west of "Anambah". In a low-lying patch of country along a small stream three distinct basalt flows are interbedded with mudstone.

2. *Lochinvar Section.*

This section begins on pebbly tuff just south of a creek to the north of the Roman Catholic Convent, and is continued south to Lochinvar Station where the nose of the Lochinvar anticline occurs, and then west along the railway line, linking up with overlying *Allandale Stage.* This is a fairly complete section through the Lochinvar Stage, but in its compilation a certain amount of generalization has been employed. Thus some blue sporangia-bearing cherts exposed beside the main northern road to the west of Lochinvar are incorporated in the statement of the section.

The lowest unit is a pebbly tuff, 50 feet thick, followed by conglomerate 300 feet, and then sandstone 200 feet. This is succeeded by 150 feet of basalt which is on the horizon of the Village of Gosforth basalt. Then follow basic tuff 50 feet thick, 10 feet of hard siliceous tuff and about 10 feet of sporangia tuff or chert, leading into a considerable amount of sandy shale. Overlying the shale is the second basalt horizon and then more shale succeeded by 150 feet of fine shaly sandstone, the top of the bed being crowded with *Ptycomphalina* in narrow bands. Drift specimens of *Gangamopteris* also occur here. This is an important bed in being the lowest horizon in New South Wales from which the *Gangamopteris–Glossopteris* Flora has been recorded. It is also the first horizon since the plant-bearing tuff of Gosforth to yield marine fossils. Fine shaly sandstone separates the two *Ptycomphalina* bands from one another. The next unit is a shaly mudstone, free from fossils, and 200 feet thick. The section now is obscured for about 200 feet, and then comes the third basalt horizon of the Lochinvar Stage. This is 200 feet thick approximately, and is seen on the east side of the road in thoroughly weathered condition. This is followed by 200 feet of sandy shale with odd erratics, seen in the railway cutting.

On the main northern road between Lochinvar and the Allandale turn-off these last-mentioned beds are strongly fossiliferous in one or two zones, details of which are given in the fossil lists below.

Pursuing the railway section westward one finds next a shale unit about 80 feet thick, with distinctive bluish fine-grained bands carrying plant remains. In this unit are scattered erratics of quartzite, porphyry and slate up to two feet in diameter. This is considered to be the second glacial horizon in the Lower Marine succession. Next comes the fourth basalt horizon in the Lower Marine.

Referable to this horizon are the patches of basic soil seen on the road from Sawyers Gully to Lochinvar Station. Clay shale and ferruginous grit now follow for 300 feet with a few erratics at the top. Then come spheroidally weathering basic tuff 100 feet thick, and pebbly shales 50 feet thick. This completes the *Lochinvar Stage* as the succeeding rocks are at the base of the *Allandale Stage.* About 200 feet from the top of the section just described is the only Lower Marine, a glendonite horizon in the Hunter region.

A tabular statement of the section follows:

	Feet.
Pebbly shales	50
Spheroidal tuff	100
Clay shale and ferruginous grit with some erratics at the top	300
Basalt and basaltic tuff (fourth horizon)	100
Shale with scattered erratics	80
Sandy tuffaceous shale with erratics	200
Basalt (third horizon)	220
(Hiatus in section, probably due to shale)	200
Shaly mudstone	200
Ptycomphalina Bed No. 2	1
Sandy shale	18
Ptycomphalina Bed No. 1	1
Fossiliferous shaly sandstone	150
Basalt (second horizon)	50
Sandy shale	300
Sporangia tuff	10
Hard tuff	10
Basic tuff	50
Basalt (amygdaloidal) No. 1 horizon	150
Sandstone	200
Conglomerate	300
Pebbly tuff	50
Total	2,740 Feet

3. *Eelah–Comerfords Section.*

This section takes in the interval from the base of the Series up to basalt which here immediately underlies the *Allandale Stage*. On top of the Carboniferous Lochinvar Shales, as seen in Eelah Creek, comes mudstone containing plant remains for 25 feet, followed by buff sandstone for 100 feet. Then comes the first horizon of sporangia tuff, which is 60 feet thick. Pebbly mudstone and sandstone now succeed, and are followed by bluish sporangia tuff (second horizon), also 60 feet thick. It is to be expected that the seasonal development of the sporangia would be reflected in the zonal and restricted character of their occurrence in these rocks.

The next group of rocks, 600 feet thick, comprises tuffaceous sandstone and tuff, some almost of quartzitic texture, and a very thin intercalated flow of basalt. These clastic rocks cross the Eelah–Rosebrook Road and make an imposing scarp on the left bank of the Hunter River, where they dip E.S.E. at 18°.

Basalt flows and associated basic tuffs aggregating 400 feet now succeed, and lead up to the base of the *Allandale Stage*. A summary of the section is as follows:

	Feet.
Basalt and tuff	400
Tuffs and tuffaceous mudstone	300
Mudstone and tuff, interbedded	280
Basalt	10
Coarse tuff	50
Sporangia tuff or chert (No. 2)	60
Mudstone	50
Pebbly sandstone	60
Sporangia chert (No. 1)	60
Buff sandstone	100
Mudstone with plant remains	25
Total	1,395 Feet

4. *Section from Paterson–Tocal Region.*

West of Paterson township overlapping of Lower Marine units brings certain sporangia-bearing cherts into contact with underlying Carboniferous tillite. These cherts are 25 feet thick and are followed by basalt for 20 feet and then more bluish sporangia cherts 150 feet thick, and some dense blue cherty rocks with plant stems, which

pass into a band of sporangia-tuff (third horizon) overlain by more tuff and a peculiar felsite breccia recalling the Kuttung volcanic facies. The rocks in this region are disposed in a flat syncline trending more or less east and west, the south side of the structure being exposed immediately north of Webbers Creek Railway Bridge.

Although the present section is taken at no great distance from the Eelah region and in the same structural unit (the Mindaribba Basin) one finds several differences in the sequence. The most important of these is that the basalts at Comerfords are evidently higher stratigraphically than those at Paterson.

The Paterson section may be summarized as follows:

	Feet.
Felsite breccia	90
Coarse tuff	50
Fine sporangia-chert (No. 3)	30
Plant stems in mudstone	50
Basalt	200
Sporangia-tuff (No. 2)	150
Basalt	20
Sporangia-tuff (No. 1)	25
Total	615 Feet

From the sections detailed above a generalized statement has been prepared as shown in Text-figure 2.

The consideration of the *Lochinvar Stage* in the Cranky Corner Basin will be made at a later stage in this paper.

THE ALLANDALE STAGE.

The strata grouped into this Stage are distinguished by the following features:

1. They appear to have been developed about the time of some physical change in the Hunter region. This was localized in several places and amounted to uplift of the floor of the deposition-area, giving islands from which coarse conglomerates were derived.

2. They comprise two palaeontological horizons, the more important *Eurydesma cordatum* bed, and the zone rich in *Aviculopecten* and *Deltopecten*. These organisms were able to subsist in the coarse gravelly, littoral environment. (In four out of five places where the *Eurydesma* bed occurs in the Lower Hunter the rock is a conglomerate.)

3. Distinctive tuffaceous rocks broadly grouped in the past under the title of the "Harpurs Hill Sandstone" indicate an outburst of explosive vulcanicity more pronounced than any that had taken place hitherto in Lower Marine time.

Thus the separation of these beds from the rest of the Lower Marine and the recognition of the *Allandale Stage* is justified, particularly also because of the importance of the *Eurydesma* horizon in the correlation of the Permian beds of Eastern Australia.

1. *The Allandale Section.*

(*a*) *Preliminary.*

This section has been compounded from exposures available as follows:

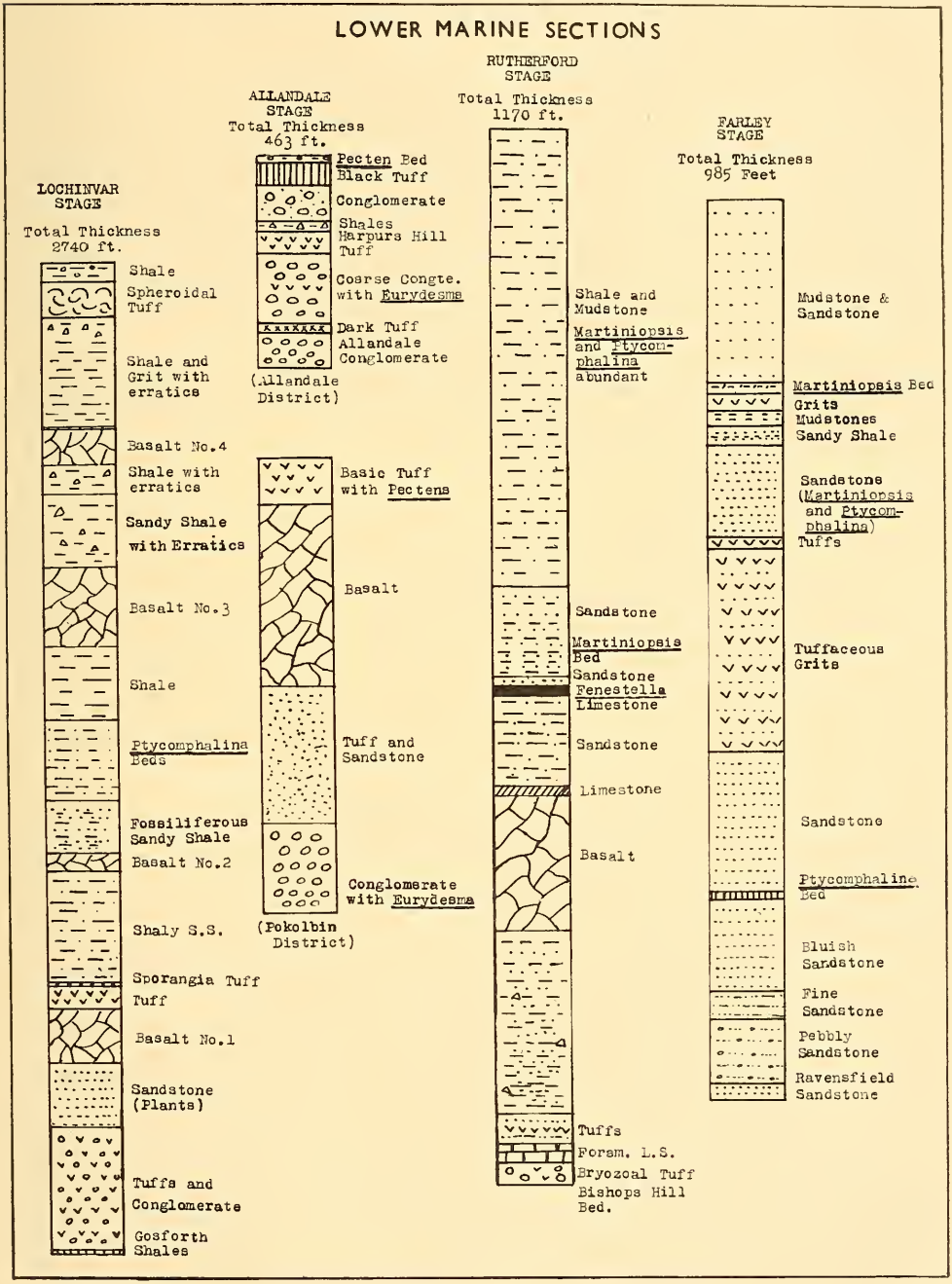
(i) In the railway cuttings to the east of Allandale Station, where the rocks form part of the western side of the Lochinvar anticline;

(ii) from the old road between the station eastward to the overbridge;

(iii) from the Allandale cross-road.

The beds found in the railway cuttings can be traced north-westerly to the cross-road leading from the main Northern Road to Allandale Station, and beyond this. North-west from the cross-road the conglomerate thins out and the tuffaceous sandstone is strongly developed as may be seen beside the road at the summit of the rise near Harpurs Hill. About 12 chains further west along the main road some coarse tuffs and sandstones belonging to the Stage and overlapping the Harpurs Hill horizon are artificially exposed in a small quarry, just north of the road. Here fossils are abundantly developed.

As regards the palaeontological horizons, there are, in addition to the well-known *Eurydesma* bed, and the important *Pecten* horizon, several richly fossiliferous zones, the prominent genera being *Martiniopsis*, *Keenia*, *Spirifer*, and *Fenestella* (see footnote, p. 221).



Text-figure 2.

(*b*) *Details of the Section.*

We begin with 80 feet of conglomerate which overlies the topmost shaly beds of the *Lochinvar Stage.* This is succeeded by dark greenish-black tuff 20 feet thick, and then by 150 feet of very coarse conglomerate. This conglomerate is split in only one place by a band of tuffaceous sandstone of the "Harpurs Hill" type, 15 feet thick. This conglomerate contains the famous *Eurydesma* Bed, great numbers of the lamellibranch, together with *Keenia, Notomya, Edmondia* and other types, making a regular shell-bank deposit eighteen inches thick.

Succeeding the conglomerate whose pebbles are almost entirely of albitized amygdaloidal andesite derived from the Kuttung inlier to the south, come 50 feet of the true Harpurs Hill tuff overlain by 20 feet of soft brown shale with erratics. Next follow 80 feet of conglomerate, similar in structure and lithology to that exposed in the more easterly of the two railway cuttings. Succeeding the conglomerate is a dark greenish-black tuff, obviously of the same general facies as the "Harpurs Hill" type. Towards the top of this unit one finds the *Pecten* bed. This is about three feet in maximum, but 1½ feet in average, thickness, and contains numerous examples of *Deltopecten* together with fragmental material partly representing broken-up shells of *Spirifera* and *Martiniopsis. Fenestella* is also prominent on this horizon, which is followed by the topmost unit of fine conglomerate, 10 feet thick.

The section on the Allandale cross-road indicates clearly that glacial conditions were present not far from the Hunter region in Allandale time, this being the third glacial epoch of the Lower Marine Series.

The Allandale Section is tabulated thus:

	Feet
Pebbly mudstone	10
Tuff with *Pectens*	3
Blackish-green tuff	50
Conglomerate (andesite boulders)	80
Soft brown shales with numerous erratics	20
Tuffaceous sandstone (Harpurs Hill type)	50
Heavy Conglomerates with 15 ft. tuff band and *Eurydesma* horizon, 2 ft.	150
Greenish-black tuff	20
Conglomerate	80
Total	463 Feet

2. *The Allandale Stage in the Pokolbin District.*

The Pokolbin area is very complicated geologically, and the elucidation of the detailed stratigraphy and structural relations of the Kuttung and Permian rocks will be possible only after much more field work has been carried out.

The somewhat special nature of the structural features of the Pokolbin region as a whole is due to the following:

(i) Permian sedimentation probably did not take place until the beginning of the *Allandale Stage.*

(ii) The conglomerates accumulated upon an uneven floor during conditions that gave rise to strong overlap.

(iii) The folding of the Lochinvar anticline was attended by the development of local structural irregularities due to the Permian sediments being squeezed around and against the rigid inliers of Kuttung rocks.

It is somewhat difficult in this district to know just where to draw the line between the Allandale and Rutherford Stages, but by tracing the latter from areas of favourable exposure it is clear that the only units definitely to be assigned to the *Allandale Stage* at Pokolbin are the conglomerates and sandstones which in places mantle the lower slopes of the Kuttung inliers, and the overlying basalts and basic tuffs.

The conglomerate, 200 feet thick, is very distinctive, possessing a fair variety of volcanic pebbles, derived from the Kuttung floor. The coarse andesitic matrix contains

Eurydesma cordatum as well as other typical Lower Marine forms. Excellent exposures are seen in many parts of the area. The sandstone is fairly coarse and definitely tuffaceous in places, being 300 feet thick.

The succeeding basalt is obviously of submarine development, being sometimes vesicular, sometimes amygdaloidal with zeolites, and in places showing pillow structure. The maximum thickness is 400 feet. It is overlain by basic tuffs approximately 100 feet thick containing many *Pectens*. Overlying these come the foraminiferal and bryozoal marly limestones of the *Rutherford Stage*.

3. *The Allandale Stage at Comerfords.*

In the neighbourhood of the cutting where the Eelah Road crosses the North Coast Railway the *Allandale Stage* is exposed in the form of strong outcrops of a coarse, ill-assorted shingle and tuff deposit in which *Eurydesma*, *Spirifer*, *Fenestella* and *Deltopecten* are abundantly developed. This bed is about 20 feet thick, and rests on a basement of basalt. It is clear that here the *Eurydesma* and *Deltopecten* horizons have coalesced. Immediately following the tuff is a fine-grained felspathic rock which suggests volcanic activity coeval with that which produced the tuffs of Harpurs Hill and Pokolbin.

THE RUTHERFORD STAGE.

These strata, in so far as they occurred on the eastern side of the area, were referred to by Professor David as the Rutherford Shales, being regarded as the upper portion of the *Lochinvar Stage*. The present writer has instituted a separate Stage because of the following reasons:

(i) Detailed study of the areas of this Stage has provided much information not available when Professor David wrote his Memoir. This indicates that the rocks are fairly definitely marked off stratigraphically and lithologically from the underlying *Allandale Stage* on the one hand, and from the overlying *Farley Stage* on the other, except perhaps in the case of the topmost part of the *Rutherford Stage* on the eastern side of the Lochinvar anticline.

(ii) Within the Stage there is a greater variation of facies-development than in any other part of the Lower Marine in the Hunter region. Thus in the east the rocks are mostly shales, definitely non-calcareous, except for very local concretionary structures. In the Pokolbin–Rothbury–Illalong districts, however, there is extensive development of marly shales, foraminiferal and bryozoal limestones.

(iii) In the Stage are two well-marked fossiliferous zones which are of distinct stratigraphical value. These are:

(*a*) Foraminiferal and Ostracodal marl and limestone containing also *Bryozoa* and other fossil remains, this being the horizon of the well-known Pokolbin unit described by Chapman and Howchin (1905). This occurs about 200 feet above the base of the Stage.

(*b*) Sandy shale with abundant remains of *Spirifer*, *Martiniopsis* and *Fenestella*. This occurs about 700 feet above the base of the Stage.

A. B. Walkom noted two horizons of limestones in the rocks which I have designated the *Rutherford Stage*, and as far as I can make out from his paper, the two horizons given above are identical with his zones (see Walkom, 1913). However, he did not deal with the rocks of the marly type, rich in foraminifera, which are abundant in the Old Rothbury–Black Creek–Chick Hill District.

Through the country stretching to the south and south-west of a line from Allandale to Red Hill Trigonometrical Station, and particularly to the west of Black Creek these horizons can be traced, and break the monotony of the rest of the Stage which is formed chiefly of buff-coloured sandy shale and sandy tuff. The foraminiferal limestones do not appear anywhere on the eastern side of the Lochinvar structure, but the other zone marked by many Brachiopods and *Fenestella* has been located at two places on the

eastern side. These are near Bishops Bridge, and in the bank of Black Creek in portion 25, Parish of Allandale on the edge of the Parish. The latter outcrop is identical in appearance and fossil assemblage with that in Portion 63, Parish of Rothbury.

The basal unit is a pebbly tuff with *Bryozoa*, which shows a marked lithological contrast with the underlying *Allandale Stage*. It is here called the *Bishop's Hill Horizon*, because of its strong development in that area.

SECTIONS IN THE RUTHERFORD STAGE.

It will now be appropriate to take the details of development along various section-lines. In the case of the intricate area around Pokolbin and Mt. View a generalized section has been determined.

1. *The Rutherford Section in the Pokolbin District.*

The following has been prepared from areas adjacent to one another:

	Feet.
Sandstone (probable equivalent of Ravensfield)	—
Sandy mudstone with abundance of *Martiniopsis* and *Ptycomphalina*	500
Sandy shale	100
Ferruginous sandstone with *Martiniopsis*	10
Sandstone	10
Sandy limestone with *Fenestella*	10
Shaly sandstone	100
Sandy limestone	10
Basalt	150
Sandy shale with erratics	200
Fine sandstones and tuffs	35
Foraminiferal limestones	20
Bishops Hill Bryozoal tuff	25
Total	1,170 Feet

In the neighbourhood of Jackson's Hill and to the north the broad succession is:

	Feet.
Sandy shale with erratics	200
Sandstone with *Martiniopsis* and *Spirifer*	30
Shaly sandstone with *Fenestella*	50
Sandstones, often ferruginous	200
Marls and Ostracod limestone	400
Total	880 Feet

Near Pokolbin itself, where Foraminifera were first collected, a little to the west of "Ben Ean" vineyard, and in the neighbourhood of "Maluna" in Portion 112, Parish of Pokolbin, we have the following section:

	Feet.
Foraminiferal Limestone with Bryozoa and *Pectens*	4
Fossiliferous shale	5
Limestone with *Fenestella* and *Stenopora*, etc.	20
Blue limestone	5
Mudstone with *Platyschisma* and octracodal remains	10
Total	44 Feet

These strata succeed the *Allandale Stage*.

The detail of the Foraminifera which occur in the topmost bed can be obtained from a perusal of the Memoir by Howchin and Chapman (1905).

There are several places in the broad belt of *Rutherford Stage* rocks north of Pokolbin where interesting sections are available.

Thus a cutting on the main road from Pokolbin to Branxton at a point about five miles south of Branxton exposes the following section of the *Rutherford Stage*:

	Feet.
Fossiliferous sandstone with marked band rich in *Martiniopsis* and *Spirifer*	25
Finely bedded shales with shell fragments	25
Sandstone	20
Pebbly ironstone with fossils	2
Fine shales with scattered pebbles	20
Total	92 Feet

The highest unit in the above section is the uppermost of the two fossil zones already referred to at some length above.

Between Mt. View and Pokolbin on the road running west of Jackson's Hill there are many exposures of the foraminiferal limestones and associated rocks. In the cutting near portion 106, Parish of Pokolbin there occurs a beautiful polyzoal limestone, which is approximately the equivalent of the "Ben Ean" horizon. The section on the roadside is as follows:

	Feet.
Polyzoal limestone	12
Marly shale, with small fossils	15
Limestone with *Stenopora*	12
Calcareous shales with *Fenestella*	12
Polyzoal limestone crowded with small fossils	10
Total	61 Feet

The only place on the west side of the Lochinvar anticline where the sandy phases of the Rutherford are developed to the exclusion of the calcareous types is along the right bank of the Hunter River to the N.E. of Greta and east of the Leconfield Road. Here in a cliff and scarp-section one can note the presence of sandy rocks, mostly unfossiliferous, but possessing one band with fragments of *Fenestella.*

Passing over to the eastern side of the area we find a section of the Upper Rutherford exposed on the main Northern Road about three miles from Maitland. Beginning opposite the gate of a small cemetery we have—

	Feet.
Brown sandstone (Ravensfield horizon)	—
Pebbly reddish sandstone	15
Hard red tuffaceous sandstone	10
Current bedded sandstone	25
Brown sandstone with shell fragments	34
Pebbly sandstone	12
Whitish shale with *Ptycomphalina*	10
Buff sandstone	12
Fine grained sandstone with *Spirifer*	15
Brown tuffaceous sandstone	40
Total	173 Feet

A fuller section of the *Rutherford Stage* in this eastern part of the province is given in the cuttings along the railway line between Lochinvar and Farley.

Starting at a point east of Lochinvar and near the 125 mile peg on the railway line, the section begins on very soft and poorly exposed shales, but to the east stronger outcrops are seen and we have the following:

	Feet.
Shales	80
Cherty shale with tiny plant stems	60
Sandstone with small fossils	30
Calcareous concretionary shales	60
Hard sandstone	35
Bluish chert	40
Decomposed bluish mudstone	20
Shaly mudstone with shell fragments	30
Sandy mudstone	40
Alternating shales and sandstones with occasional plant remains and odd layers rich in *Martiniopsis*	280
Total	675 Feet

Reviewing the data for the Stage it is seen that the maximum thickness is 1,170 feet.

THE FARLEY STAGE.

This Stage, the topmost of the Lower Marine Series, extends from the base of the Ravensfield Sandstone to the base of the Greta Coal Measures. The maximum thickness measured by the writer is 985 feet, but in some places the Stage dwindles to about 125 feet thick.

The persistence of the Ravensfield Sandstone has made it relatively easy to refer to their correct stratigraphical positions certain sandy beds which occur associated, both above and below, with that sandstone. Although there are many arenaceous horizons in the Rutherford and Farley Stages which approximate in general lithology to the Ravensfield Sandstone, certain features about the latter give it a character by which a worker thoroughly accustomed to it is able, in almost every case, to distinguish it from similar horizons. This sandstone was mapped by Professor David as an indicator horizon.

As regards the extent of the Ravensfield Sandstone, it is interesting to note that it ends abruptly in two places at least. One locality is near Mt. View and the other is north of Rutherford.

On "Aberglasslyn", Nicholson's Quarry has exposed a greenish-black to buff sandstone which weathers brown in a manner suggesting the Ravensfield, and so regarded by some workers. A close scrutiny of the available exposures, however, has led the writer to regard it not as the Ravensfield horizon but as equivalent to some unit in the section seen on the left bank of the Hunter River opposite "Aberglasslyn".

Distribution and Sections of the Farley Stage.

This Stage is the most consistent, lithologically, of all the groups of sediments in the Lower Marine. The beds are dominantly sandy with occasional shaly layers and are often decalcified, interbedding of rocks of differing resistance giving characteristic topographic expression. The Farley Beds have an areal distribution greater than that of any other group.

The stage is exposed in and around the village of Farley, and stretches to the south in a broad belt through the Bishops Bridge and Sawyers Gully district. From Sawyers Gully to the south and south-west the Stage is well represented, and occupies high country in the Mt. View–Milfield districts. On the west of the Mt. Bright inlier it is cut out by the Matthews Gap Fault, but reappears on the eastern side of the fault in the country north of Pokolbin. These rocks are well exposed in Black Creek west of Rothbury. Further north from here they are prominently developed on the northern and western slopes of Molly Morgan Ridge and the high country running north from the Trigonometrical Station. Further north the *Farley Stage* is found immediately east of Greta, and again well exposed east of the Leconfield Road, and near Dalwood crossing of the Hunter River. The next place northward is in the Cranky Corner Basin where the Stage is much diminished.

In the north-east of the province near Comerfords and west of Bolwarra this Stage is represented by about 300 feet of strata underlying the Greta Measures. In this case the Farley beds thin out quickly and eventually become overlapped by higher beds. Marine fossils are abundant on some horizons. Apart from the fauna of the Ravensfield Sandstone, there is a fairly wide variety of type, as shown by the list given below, some thin ironstone bands being crowded with *Martiniopsis* and *Spirifer*. *Conularia* is also quite common in certain gritty ferruginous rocks, and *Ptycomphalina* is abundant on two zones which occur at widely separated places.

Sections in Farley Stage.

Three sections are taken to illustrate the stratigraphical features.

(1) *Farley Station to Farley Road Corner.*

This gives a completle sequence, and may be stated as follows:

	Feet.
Mudstones and brown sandstones	200
Shale crowded with *Martiniopsis*	12
Tuffaceous grit	20
Bluish mudstone	13
Bluish sandy shale	20
Sandstone with *Martiniopsis* and *Ptycomphalina*	100
Plant-bearing tuff	15
Bluish-grey tuffaceous grit	220
Sandstone	155
Shale rock with *Ptycomphalina*	10
Bluish sandstone	100
Fine buff sandstone	30
Pebbly sandstone	70
Ravensfield sandstone	20
Total	985 Feet

(2) *On Bushland track south of Mt. View.*

The section begins about eight chains from the Mt. View school on a sandy unit which is just above the foraminiferal limestone at the top of the Rutherford Stage, the Ravensfield sandstone having temporarily failed. The following is a summary of the Section:

	Feet.
Buff and brown sandstones	600
Shaly sandstone with *Ptycomphalina*	10
Mudstones with plant stems	100
Sandstone with *Martiniopsis*	5
Concretionary Limestone	10
Sandstones with *Martiniopsis* band	50
Calcareous shales with fossils	10
Sandy and slightly tuffaceous beds	100
Gritty calcareous tuff with *Fenestella*	10
Total	895 Feet

(3) *Farley Stage on the extreme west of the Province.*

North of the Pokolbin inliers (where the Farley Stage is excluded by the Matthews Gap Fault), the strata of this division emerge as the fault swings a little to the west of north and transgresses successively younger beds at the surface outcrop. The lithology of the Farley representatives here is similar to that of the beds on the Sawyer's Gully road. A section was measured from the outcrop of the Ravensfield Sandstone beside the bridge over Black Creek where crossed by the Pokolbin–Branxton road. The details are as follows:

Sandstone and grits	100
Grey sandstone	10
Blue sandy shale with plant remains	12
Shale	2
Fine blue shale with fragments of Brachiopods	3
Sandstones with plant remains	20
Blue shales with *Spirifer*	20
Bluish-grey mudstone	100
Sandy tuffaceous rocks with worm tracks	20
Buff sandstones with pebble beds, occasional shaly layers and some fragments of shells	430
Ravensfield sandstone	20
Total	737 Feet

THE LOWER MARINE ROCKS OF THE CRANKY CORNER BASIN.

This basin is entirely divorced from the rest of the Permian province. On its north side the Permian are brought against the Carboniferous by the Webbers Creek

Fault, a fracture connected with the Hunter Overthrust System. Elsewhere the relations of the Lower Marine to the underlying Kuttung is one of essential conformity.

The chief interest of the Basin is that, although lying to the west of the probable axis of early sedimentation in the Lower Marine trough, the Lower Marine displays a condensed section of representatives of the Lochinvar, Allandale, Rutherford and possibly Farley Stages, the total thickness being about 810 feet.

A. B. Walkom described the strata of the Basin in 1912, and the present investigation extends the data given in his paper.

The lowest beds are coarse plant-bearing sandstones exposed on the N.E. corner of the Basin against the Webbers Creek Fault. In the extreme N.W. of the area blue chert occurs which is to be correlated with other occurrences as discussed below. Over a good deal of the area of the Lower Marine outcrop there are flows of amygdaloidal basalt which often rest directly upon the Kuttung Series. Beginning with the basalt in the S.W. there follows bluish chert about 180 feet thick. The next 200 feet comprises several fossiliferous bands of shale, the most significant being two *Fenestella* horizons, separated by grey shale. Small fragments of lammellibranchs occur in the beds overlying the upper *Fenestella* bed and then follow sandstones with well preserved *Spirifer* and *Martiniopsis*. On top of these comes the *Eurydesma* Bed. This unit is crowded with thousands of shells, which are more abundantly developed here than anywhere in the Hunter region. The matrix of the mass is a greenish tuffaceous grit or sandstone. Overlying this zone is a buff-coloured series of tuffaceous sandstones and grits with almost a quartzitic appearance. These are partly Rutherford and partly Farley. On top of these rocks come the Greta conglomerates. The section may be tabulated thus:

	Feet.
Tuff and sandstone, etc.	160
Eurydesma bed	15
Yellowish shale	50
Blue shale	15
Fossiliferous sandstone	10
Blue chert with small lamellibranchs	20
Massive sandstone	30
Fenestella bed No. 2	5
Grey shales	50
Fenestella bed No. 1	5
Mudstones	40
Olive green mudstone	10
Blue cherts	180
Basalt	120
Plant-bearing sandstone	100
Total	810 Feet

THE LOWER MARINE IN THE MUSWELLBROOK DISTRICT.

From a brief examination of the Lower Marine at Muswellbrook, the writer can add practically nothing to what H. G. Raggatt (1929) has reported. Thus there are two main sets of rock comprising the *Gyarran Series* and forming a relatively small area of outcrop. These are amygdaloidal basalts (identical with those of the Lower Hunter), overlain by rhyolitic lavas, breccias and tuffs. The former are about 600 feet thick and the latter 115 feet. There are no sediments worthy of examination, as the tuffs are thoroughly igneous.

CORRELATIONS OF SECTIONS.

A certain amount of correlation can be effected between sections in the various Stages from fairly widely separated districts, but considerable difficulty has been encountered because of the scarcity of outcrops in low-lying country and the unreliable character of the dips shown in surface expression of some strata.

The Lochinvar Stage.

The plant-bearing sandstone so well developed in the Gosforth district is probably to be correlated with the coarse tuffaceous rock with plant stems at the N.E. of the

Cranky Corner Basin and with some plant-tuffs at Eelah. (The question of the correlation of the basalts is left until later.) The blue sporangia cherts which occur in the roadside exposures west of Lochinvar are regarded as the equivalent of one of the Paterson Horizons, probably the lowest which outcrops on the road west of the township. The similar cherts in the North Coast Railway cutting near Quarry Creek, Tocal, are the equivalent of the highest of the chert horizons on the Eelah road section. The blue cherts on the north-west and in the southern part of the Cranky Corner Basin are the equivalent of the rocks on the road west of Lochinvar, corresponding also to the similar rocks from Butterwick and Dunns Creek district, east of the Paterson River.

The *Fenestella* beds in the Cranky Corner Basin, seen best in the creek below Mr. Thomas' property, are probably on the horizon of the marine shales outcropping on the Northern Road one mile west of Lochinvar, and also of the similar strata overlying the *Ptycomphalina* bed near Lochinvar station. *Fenestella* is particularly abundant in this horizon near Lochinvar.

The Allandale Stage

The *Eurydesma cordatum* horizon is developed at five places. In two of these *Pectens* are commonly associated with the *Eurydesma*, mostly in the beds immediately overlying the conglomerates. This is the case at Comerfords and at Pokolbin and is due to convergence in the sequence whereby 280 feet of strata have been cut out.

The lithology of the matrix to the *Eurydesma* fossils is variable. At Pokolbin and Allandale the rock is a coarse conglomerate with tuffaceous cement; on the south side of Blair Duguid a sandy tuff with large glacial erratics; at Cranky Corner a greenish tuffaceous sandstone, and at Comerfords a very gritty impure calcareous tuff with irregular boulders.

The Harpurs Hill tuffaceous sandstone of the Allandale district can be correlated with the tuff overlying the *Pecten* Beds at Comerfords and with the basic tuff on the road near Portion 193, Parish of Pokolbin. Greenish tuff associated with basalt on "Aberglasslyn" is also to be placed at this horizon.

The Rutherford Stage.

Mention has already been made of the essential contrast in the general lithology of this Stage as shown by its outcrops on eastern and western sides of the province. In spite of this change, correlation can be carried out by using the horizon of concretionary limestone carrying abundant *Spirifer* and *Martiniopsis*. Along the sector from Red Hill and the Molly Morgan Ridge through to Pokolbin and Mt. View correlations can be made between detailed sections of the marls and bryozoal limestones. Thus one unit which can be detected in many sections is a grey limestone with much *Fenestella* but also an abundance of tubular *Stenopora*.

The Farley Stage.

Apart from the Ravensfield sandstone which is so uniform and persistent there are two zones rich in *Martiniopsis* and one with *Ptycomphalina* which help to link the widely separated Pokolbin–Milfield and Farley districts. These three horizons are well displayed on the Farley road, the main Northern Road, the Sawyer's Gully Road, and on the bushland track south-west of Mt. View. Also two of the horizons can be traced in the bed of Black Creek west of Old Rothbury.

Horizons and Correlations of the Lower Marine Basalts.

An exhaustive petrological examination and much more field-work are required before many of the problems peculiar to these rocks are solved. Concerning their correlation it is clear that they do not occupy constant stratigraphical positions.

The section from Gosforth to Lochinvar Station and westward on to Allandale shows the presence of four horizons of flows and associated tuff, and examination of the small quarry to the east of Lochinvar reveals that the second group of basic rocks is composite, embracing at least two and perhaps three flows.

Almost all the flows are or have been vesicular, and many are now amygdaloidal. The textural features, however, are of no use in linking flows stratigraphically.

The basalts of Lochinvar Village, Gosforth, Anambah and near Lochinvar Station can be correlated satisfactorily amongst themselves. The basalts of the Cranky Corner Basin are regarded as being on the same horizon as that in the village of Lochinvar outcropping on the roadside. This view is based on the relations between the basic rock and the sporangia cherts in the two places.

Difficulty arises in attempting to correlate the great quantity of basalt about Paterson and Northern Tocal with the flows near Comerfords and a little to the north thereof.

At Comerfords the main group of vesicular and massive basalt underlies the *Eurydesma* bed, and this is well above the highest sporangia cherts. At Paterson the bulk of the basalt is between the two main sporangia chert horizons, and this suggests a partial correlation of the Paterson units with the second group of flows at Lochinvar.

In the neighbourhood of "Aberglasslyn" a thick mass of amygdaloidal basalt and basic tuff appears to be stratigraphically above the Comerfords flows. This immediately suggests some linking with the somewhat similar rocks which overlie the *Eurydesma* beds at Mt. View—probably the highest flows (stratigraphically) in the Lower Hunter River areas.

It is of interest to note that as one goes northward up the Hunter Valley one finds the basalts becoming younger in general, although their petrological characters remain fairly constant.

The Lower Marine basalts of Muswellbrook, to which reference has already been made, are very similar petrologically to the Lochinvar Village type, but any direct correlation between the two districts is impossible.

Speaking generally about these basic rocks, it would appear that for a considerable portion of Permian time the Hunter region was underlain by an alkaline basic magma from which lava was drawn off at successive stages, and that basic tuff was frequently developed, but chiefly in association with the later flows.

SUMMARY OF THE STRATIGRAPHY.

From the foregoing details of the succession we arrive at the following summarized statement of the sequence, giving maximum thicknesses for the various Stages:

	Feet.
Farley Stage	985
Rutherford Stage	1,170
Allandale Stage	1,000
Lochinvar Stage	2,740
Total	5,895

POSSIBLE UNDERGROUND EXTENSIONS OF THE LOWER MARINE SERIES WEST AND SOUTH OF THE HUNTER VALLEY.

Considering the *Lochinvar Stage* and its position in the sequence of groups in the geosyncline, I would emphasize the probability that a great development of basalt exists underground between the Lower Hunter and the Muswellbrook area. This is based on the following criteria:

(*a*) The increase of Lower Marine basalt in regions west of the meridian of the Lochinvar–Gosforth zone.

(*b*) The abundance of volcanic rock and the absence of true sediment in the Lower Marine Sections at Muswellbrook.

(*c*) The evidence of basalt ascending stratigraphically as one goes westerly from the Lochinvar–Cessnock line.

In view of the heavy sedimentation implied in the Rutherford Stage of the country between Old Rothbury, Pokolbin and Mt. View to Milfield, the writer is inclined to the view that in a prolongation of the axis of the Lochinvar Dome and particularly along the trend of the Pokolbin section of the Dome, we may expect to find fairly extensive

development of that Stage to the S.S.W. The *Allandale Stage* is marked by much basic rock, but one does not expect any considerable development of the sediments of the Allandale horizons, in the country south and west of the Lochinvar Anticline.

In the general problem of development of the Lower Marine beyond the Hunter, the significance of the Cranky Corner Basin must be appreciated. In that sequence we find a condensed section, showing a continuity of stratigraphical development (qualitatively, although not quantitatively) over a large section of the Permian trough of sedimentation, because the Cranky Corner Basin lies to the west of the strike of the main axis of sagging in the trough. Thus, traced westward from the region lying north of Pokolbin, the Lower Marine Series may be expected to thin out so as to give very much reduced thicknesses for at least the Lochinvar, Allandale and Rutherford Stages.

The most important underground extension of the *Rutherford Stage* would be to the south.

Coming now to the *Farley Stage*, we note considerable development of strata on the extreme west of the Hunter Province. It would appear that this upper arenaceous part of the Lower Marine succession would be the most likely of all units to show a sustained extension of lithological type underground to the west.

In conclusion, it appears that the typical Lower Marine section beneath the country to the west and south-west of the Lochinvar Dome would be basements of basalt with little *Lochinvar Stage* material, followed by *Rutherford Stage* in fair development in the south, and less well developed in the north, overlain by a considerable thickness of the arenaceous Farley Beds.

List of Fossils of the Lower Marine Series.

In the foregoing text reference is made in many places to certain fossil-types which are characteristic of well-known horizons, and some remarks upon the general nature of the faunal content of the various groups of strata are given. In this section lists are provided for purposes of general reference.

These lists are for the most part based upon the palaeontological data in Walkom's papers (1912, (*a*) and (*b*)), to which are added names of fossils more recently described or recorded. The Foraminifera, Bryozoa and Ostracoda are those described in recent years by Crespin and Crockford (see references).

It is hoped that the grouping of fossils into lists for the respective Stages may assist future workers. The data are not absolutely exhaustive as the numerous records of Permian fossils in N.S.W. Mines Department Reports have not been revised in the light of modern palaeontological knowledge and classification.

THE LOCHINVAR STAGE.

(*a*) *The Lower Portion in the Gosforth District.*

Crinoid stems and ossicles, *Polypora internata, Fenestrellina* fossula, F.* sp., *Seminula* sp. nov., *Martiniopsis radiata, Spirifera* aff. *tasmaniensis, Deltopecten linaeformis, Aviculopecten englehardti. A. tenuicollis, A. mitchelli, Chaenomya* sp., *Conocardium* sp. nov., *Moeonia* sp. nov., *Orthoceras* sp.

In the plant-bearing sandstone, *Spirifera* of the *striati* group, *Dielasma, Conularia, Platyschisma.*

(*b*) *The Main Part of the Lochinvar Stage.*

Tribrachiocrinus sp., indeterminate crinoid, crinoid stems, *Fenestrellina* (?) *internata, F.* (?) *fossula, Stenopora tasmaniensis, Spirifer duodecimcostata, S. stokesi, S. avicula, S. vespertilio, S. tasmaniensis, Martiniopsis subradiata* var. cf. *morrisii, Productus cora* var. *farleyensis, Strophalosia jukesi. Chonetes* (?) sp., *Edmondia* (?) *noblissima. Chaenomya* sp., *Merismopteria* sp. nov., *Aviculopecten sprenti, A. tenuicollis, A. englehardti, Deltopecten subquinquelineatus, D. farleyensis, Moenia* sp., *Pleurophorus, Notomya* (?), *Pachydomus, Mourlonia rotundatum, Ptycomphalina triflata, P. nuda, Platyschisma, Keenia, Conularia levigata.*

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* Dr. Ida Brown informed me that she had recently heard from Mrs. Beattie (Joan Crockford) that Dr. M. K. Elias intends to use *Fenestella* as a valid name (as used for 112 years). An application for suspension of Rules of Zoological Nomenclature for the generic name *Fenestella* Lons. 1839 was submitted to the International Commission on Zoological Nomenclature by G. E. Condra and M. K. Elias (*Jour. Palaeont.* 15, 1941, 565-566).

The Allandale Stage.

Hyperamminoides sp. cf. *proteus, Hyperamminoides acicula* sp. nov., *Ammodiscus multicinctus, Ammobaculites woolnoughi* sp. nov., *Calcitornella stephensi, Frondicularia woodwardi, Geinitzina triangularis,* Crinoid stems, *Fenestrellina fossula, F. dispersa, Polypora pertinax, Dyscritella restus, D. porosa, Stenopora spiculata, S. etheridgei, S. johnstoni, Dielasma hastata, D. sacculus, Martiniopsis subradiata* var. cf. *morrisii, Spirifer vespertilio, S. stokesi, S. tasmaniensis, S. clarkei, Solenopsis* sp., *Chaenomya etheridgei, C.* sp., *Allorisma curvatum, Aviculopecten tenuicollis, A. squamuliferus, A. mitchelli, A. sprenti, Deltopecten illawarrensis, D. fittoni, D. linaeformis, Eurydesma cordata, Aphanaia* sp., *Modiola crassissima, Pleurophorus, Orthonota* sp., *Notomya* sp., *N. cuneata, Pachydomus antiquatus, P. laevis, P. ovalis, Orthonycia altum, Platyceras* n. sp., *Edmondia* (?) *noblissima, Palaearca subarguta, Merismopteria macroptera, M.* n. sp., *Avicula intumescens, Ptycomphalina triflata, P. morrissiana* (?) *Keenia platyschismoides, Platyschisma oculus, P. depressa, Conularia inornata, C. laevigata, Euomphalus, Bairdia nyei, Cavellina kulnurensis.*

The Rutherford Stage.

Foraminifera, Stenopora tasmaniensis, Fenestella, Protoretepora, Polypora, Spirifer duodecimcostata, S. tasmaniensis, Martiniopsis subradiata, Productus sp., *Aviculopecten mitchelli, A. tenuicollis, A. sprenti, A. squamuliferus, Deltopecten farleyensis, Moeonia carinata, Pachydomus, Ptycomphalina* (?), *Platyschisma, Euomphalus* (?).

The Farley Stage.

(*a*) *The Fauna of the Ravensfield Sandstone.*

Lasiocladia, Palaeaster clarkei, P. stutchburri, P. giganteus, Fenestella fossula, Dielasma cymboeformis, D. biundata, D. sp., *Spirifer tasmaniensis, S. duodecimcostata, Cyrtina, Martiniopsis subradiata, Solenopsis, Carimorphia* (?), *Chaenomya mitchelli, C. etheridgei, Edmondia* (?) *noblissima, Aviculopecten squamulferous, A. profundus, A. tenuicollis, A. sprenti, A. mitchelli, Deltopcten linaeformis, D. subquinquelineatus, D. farleyensis, D. fittoni, Eurydesma cordata, Moeonia carinata, Pleurophorus, Pachydomus, Astartila corpulenta, Platycerus altum, Platyschisma, Ptycomphalina triflata, Conularia inornata, Hyolithes lanceolatus, Agathiceras micromphalus, Orthoceras.*

(*b*) *The Fauna of the Upper Part of the Farley Stage.*

Textularia eximia, Hyperamminoides sp. cf. *proteus, Ammobaculites woolnoughi, Dielasma sacculus, D. cymbaeformis, D. biundata, D. amygdala, D. inversa, Spirifer duodecimcostata, S. stokesi, S. tasmaniensis, Martiniopsis subradiata,* var. *morrisii,* var. *konincki, Productus cora,* var. *farleyensis, P. fragilis, Rhynchonella, Chonetes, Cardiomorpha gryphoides, Edmondia* (?) *noblissima, Aviculopecten squamuliferus, A. tenuicollis, A. sprenti, A. englehardti, Aphanaia* sp., *Mytilus bigsbyi, Modiolopsis, Moeonia, Pleurophorus* sp., *P. gregarius, Stutchburia farleyensis, Pachydomus, Platyschisma oculus, P. rotundatum, Conularia inornata, Goniatites micromphalus, Nuculana waterhousei.*

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References.

Browne, W. R., and Walkom, A. B., 1911.—The Geology of the Eruptive and Associated Rocks of Pokolbin, N.S.W. *Jour. Roy. Soc. N.S.W.*, 45 : 379.

Browne, W. R., and Dun, W. S., 1924.—The Stratigraphy of the Basal Portion of the Permo-Carboniferous System in the Hunter River District. *Jour. Roy. Soc. N.S.W.*, 58 : 198.

Browne, W. R., 1926.—The Geology of the Gosforth District, N.S.W., Part I. *Jour. Roy. Soc. N.S.W.*, 60 : 213-277.

Browne, W. R., and White, H. P.—The Hypersthene Andesite of Blair Duguid, near Allandale, N.S.W. *Jour. Roy. Soc. N.S.W.*, 60 : 372.

Chapman, F., and Howchin, W., 1905.—A Monograph on the Foraminifera of the Permo-Carboniferous Limestones of N.S.W. *Mem. Geol. Surv. N.S.W.*, Pal. 14.

Crespin, I., and Parr, W. J., 1941.—Arenaceous Foraminifera from the Permian Rocks of N.S.W. *Jour. Roy. Soc. N.S.W.*, 74 : 300.

Crespin, I., 1945.—Some Permian Foraminifera from Eastern Australia. *Proc. Roy. Soc. Q'ld*, 56 : 23-30.

————, 1945.—Permian Ostracoda from Eastern Australia. *Proc. Roy. Soc. Q'ld*, 56 : 31-36.

Crockford, J., 1940.—Permian Bryozoa of Eastern Australia, Part 1. *Jour. Roy. Soc. N.S.W.*, 74 : 397.

————, 1940.—Permian Bryozoa of Eastern Australia, Part 2. *Jour. Roy. Soc. N.S.W.*, 74 : 502.

————, 1942.—Permian Bryozoa of Eastern Australia, Part 3. *Jour. Roy. Soc. N.S.W.*, 76 : 258.

————, 1945.—Stenoporoids from the Permian of N.S.W. and Tasmania. Proc. Linn. Soc. N.S.W., 70 (1-2) : 924.

David, T. W. E., 1907.—The Geology of the Hunter River Coal Measures, N.S.W. *Mem. Geol. Surv. N.S.W.*, Geol. 4.

De Koninck, L. G., 1898.—Description of the Palaeozoic Fossils of N.S.W. *Mem. Geol. Surv. N.S.W.*, Pal. 6.

Raggatt, H. G., 1929.—Report on the Singleton-Muswellbrook Coalfield. *Ann. Rept. Dept. Mines, N.S.W.*, pp. 100-104.

———— and Fletcher, H. O., 1937.—A Contribution to the Permian-Upper Carboniferous Problems. *Rec. Austr. Mus.*, 20 : 150.

Walkom, A. B., 1912.—Geology of the Permo-Carboniferous System in the Glendonbrook District. Proc. Linn. Soc. N.S.W., 38 : 115-145.

————, 1912.—Stratigraphical Geology of the Permo-Carboniferous System in the Maitland-Branxton District. Proc. Linn. Soc. N.S.W., 38 : 146-159.

THE COTYPES OF FORDONIA PAPUENSIS MACLEAY.

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(*Communicated by S. J. Copland.*)

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Recently, like Boulenger (1896, *Cat. Snakes Brit. Mus.*, 3, p. 23), I suggested (1948, *Bull. Mus. Comp. Zoöl.*, 101, p. 388) that the brown water snakes described by Macleay (1877, Proc. Linn. Soc. N.S.W., II, p. 35) might be synonymous with *Fordonia leucobalia* (Schlegel) and should be re-examined. Through the courtesy of J. Henry, Esq., Curator of the Macleay Museum, and the kindness of Mr. S. J. Copland of Sydney, I have been enabled to do this.

Macleay designated no type, merely referring to "several specimens". However, the character he stresses—exclusion of the upper labials from the orbit—occurs only in the solitary male (M.M., 1466), while the scale counts and measurements furnished by Macleay (for one snake only) coincide most nearly with the male which should, therefore, be regarded as the type or lectotype. The only other character cited by Macleay as distinguishing his *papuensis* was the number of midbody scale rows which he gave as 22, actually there are 25 in all four snakes! Apparently no grounds remain for regarding *papuensis* as even subspecifically distinct from *leucobalia* when we take into account all available data of this widely distributed species.

The Macleay series (M.M., 1463–6) consists of a male and three females having preocular 1; postoculars 2; upper labials 5, the third entering the orbit (M.M., 1463–4), or the second and third (M.M., 1465), or labials entirely excluded from the orbit by an extension of the postocular (M.M., 1466); lower labials 7, first three in contact with the anterior sublinguals; midbody scale rows 25; ventrals 146–152; anals 2; subcaudals 27–33 (the highest number being present in both sexes) pairs, or a few (one to six) single.